ANNENBERG
BROWN UNIVERSITY

EdWorkingPaper No. 20-233

Catching up or Falling Behind: Measuring Middle School Achievement Trajectories for College Readiness

Angela Johnson
NWEA

Megan Kuhfeld
NWEA

Greg King
NWEA

This study presents a framework that uses academic trajectories in the middle grades for identifying students in need of intervention and providing targeted support. We apply a set of academic college readiness benchmarks to rich longitudinal data for more than 360,000 students in 5900 schools across 49 states and the District of Columbia. In both math and reading, each student was assessed up to six times (fall and spring of 6th, 7th, and 8th grade). We show that student-level and school-level demographic characteristics significantly predict academic trajectories. Compared to White and Asian students, higher proportions of Black and Hispanic student are consistently off-track for college readiness throughout middle school. Among students who started 6th grade on track, being male, Black, Hispanic, and attending schools with a higher percentage of students who are eligible for free or reduced-price lunch are positively associated with falling off track.

VERSION: May 2020

Suggested citation: Johnson, Angela, Megan Kuhfeld, and Greg King. (2020). Catching up or Falling Behind: Measuring Middle School Achievement Trajectories for College Readiness. (EdWorkingPaper: 20-233). Retrieved from Annenberg Institute at Brown University: https://doi.org/10.26300/ktcb-6459

Catching up or Falling Behind:
Measuring Middle School Achievement Trajectories for College Readiness

Angela Johnson
Megan Kuhfeld
Greg King

NWEA

Abstract

This study presents a framework that uses academic trajectories in the middle grades for identifying students in need of intervention and providing targeted support. We apply a set of academic college readiness benchmarks to rich longitudinal data for more than 360,000 students in 5900 schools across 49 states and the District of Columbia. In both math and reading, each student was assessed up to six times (fall and spring of 6th, 7th, and 8th grade). We show that student-level and school-level demographic characteristics significantly predict academic trajectories. Compared to White and Asian students, higher proportions of Black and Hispanic student are consistently off-track for college readiness throughout middle school. Among students who started 6th grade on track, being male, Black, Hispanic, and attending schools with a higher percentage of students who are eligible for free or reduced-price lunch are positively associated with falling off track.

Key Words

Academic Achievement, College Readiness, Middle School

Catching up or Falling behind:

Measuring Middle School Achievement Trajectories for College Readiness

Increasing higher education access has long been a mantra of policy advocates. The Every Student Succeeds Act (ESSA, 2015) has further enhanced the call on college access by encouraging states to include College and Career Readiness as a measure of school accountability. Currently, 33 states and the District of Columbia have some type of college readiness benchmark (Rowland Woods, 2018). Previous research defines college readiness as broadly encompassing knowledge and skills necessary to enroll in college and complete a degree (Allensworth, Nagaoka, & Johnson, 2018; Kless, Soland, & Santiago, 2013). Of these required skills, academic readiness for college-level coursework is front and center. Without the prerequisite academic proficiencies, students can be denied college admission or required to complete remedial coursework at great private and public expense.

To bolster academic readiness for college, high schools have sought to increase the availability of college preparatory courses. However, access to advanced courses is often determined prior to high school entry (Royster, Gross, & Hochbein, 2015). Due to course entrance requirements, students who are academically off-track at the end of 8th grade have few available options to participate in a college preparatory curriculum (Cassidy, Keating, & Young, 2010; Klopfenstein & Thomas, 2009; Kolluri, 2018; Museus, Lutovsky, Colbeck, 2007; Royster et al., 2015; Song & Zeiser, 2019; Xu, Fink, & Solanki, 2019). Thus, policy that aims to increase academic readiness for college must focus earlier in the education pipeline—by addressing student achievement in the middle grades. To help students access and sustain an academic trajectory that leads to college readiness and success, early monitoring and detection of needs for support is essential.

Recent research calls for the use of early indicators, generated using middle school academic and behavioral outcomes, for the dual purposes of (a) predicting high school graduation and college readiness and (b) design interventions for students at risk of falling off track or dropping out (e.g., Allensworth, Gwynne, & de la Torre, 2014; Allensworth et al., 2018). Though the measures included in the construction of these indicators vary by study context, standardized test scores are one measure commonly used to predict academic readiness for college coursework (Allensworth et al., 2014; Balfanz, Herzog, & Mac Iver, 2007). One weakness in the current approach to predicting academic readiness for college is the use of achievement scores at a single timepoint (e.g., ACT, 2012; Balfanz et al., 2007). While a one-time test score can provide valuable information for prediction, measures of student growth can provide a better indication of students' progress towards college and career readiness. Growth data is particularly useful to identify students who may not have met college readiness benchmarks but have still improved, as well as to identify students who were on track but have fallen off track and may need additional supports. Furthermore, students' academic trajectories are less strongly tied to underlying socioeconomic inequalities and more reflective of schools impacts on learning than students' achievement at a point in time (Hegedus, 2018; Reardon, 2018). However, little research exists on using longitudinal achievement patterns in middle school to help individual students become academically ready for college.

This paper is the first to leverage longitudinal academic trajectories in the middle grades to inform an early academic indicator system. We use rich assessment data for more than 360,000 students in about 5,900 schools across 49 states and the District of Columbia. In both math and reading, each student was assessed up to six times (fall and spring of 6^{th}, 7^{th}, and 8^{th} grade). The test scores are vertically scaled, allowing us to compare achievement within and

across grades, identifying when achievement growth acceleration and deceleration happen. We apply a set of longitudinal college readiness benchmarks to these unique data and demonstrate a novel, dynamic approach to an academic early indicator system. Following extant studies, we define on-track as having met or exceeded a benchmark score on the assessment (ACT, 2012; Dougherty, 2014). Thus, each student is assigned a series of up to six on-track status indicators.

This study demonstrates an early academic indicator approach that continuously monitors students' on-track status from the beginning of 6th grade to the end of 8th grade. Based on the series of on-track statuses, we identify six trajectory patterns commonly exhibited by middle school students. Then, we provide the demographic characteristics of students that follow each of the six common trajectories. Lastly, we test whether certain demographic subgroups were more at risk of falling off-track or were more likely to move on-track for academic college readiness.

Middle School Academic College Readiness

Two bodies of recent literature identified middle school academic achievement as an important predictor of academic readiness for college. The first is research on early warning systems, which sought to predict high school completion (and, in some cases, college enrollment and completion) and identify needs for intervention (Allensworth et al., 2018). The second body of research that highlights the predictive power of middle school achievement focuses on identifying students on-track for college readiness using ACT score benchmarks.

Early Warning Indicators

Studies in this line of research (e.g., Allensworth, 2013; Allensworth & Easton, 2005; Allensworth et al., 2014; Balfanz et al., 2007) developed indicators for being "on-track" to high school graduation or college readiness by leveraging a variety of academic and behavioral measures, as well as other factors that have been shown to predict education attainment, such as

eligibility for English Learner or Special Education services. In these studies, on-track is defined as having met thresholds on the relevant measures, such as test score, grade point average, credits accumulated, and number of days of school attendance. Though not the sole indicator of college readiness, academic achievement, often represented by standardized test scores, is a crucial element found in most early indicator systems.

A recent study by the University of Chicago Consortium for School Research included the Illinois standardized test scores as an indicator and found that middle school test scores were strong predictors of high school test scores but weaker as predictors of high school graduation (Allensworth et al., 2014). This study highlights that ACT scores affect the likelihood of being admitted to selective colleges as well as scholarship decisions. It is thus important to monitor middle school achievement as they predict high school test scores that are used in these high-stakes decisions. An earlier study by Balfanz and colleagues (2007) also found end-of-5th-grade and end-of-6th-grade standardized test scores to be weaker predictors of high school graduation than course grades. Taken together, these results suggest that the strength of middle school standardized test scores lies in predicting later academic achievement and not necessarily in predicting school persistence.

Predicting College Readiness Using ACT Scores

A separate line of research uses the link among three assessments provided by ACT Inc.—ACT, PLAN, EXPLORE—to predict college readiness. Collectively, this body of research points to 8th grade achievement as the most important factor in determining whether a student is going to be college- and career- ready by the end of high school (e.g., ACT, 2008; Royster et al., 2015). College readiness is conceptualized as students' probability of receiving a passing grade in a college-level course. A score of 22 on the ACT math, 18 on the ACT English, and 22 on the

ACT Reading assessment respectively predict 75% probability of receiving a C in a college-level course in math, English, or social science (Allen & Radunzel, 2017). Being on-track for college readiness is defined as meeting the cut scores on the EXPLORE assessment (administered to 8th grade students) or on the PLAN assessment (administered to 10th grade students) that predict meeting these three ACT cut scores in 12th grade.

A series of ACT studies examined the prevalence of academic mobility by looking at assessment scores taken four years apart (ACT, 2012; Dougherty, 2014; Dougherty & Fleming, 2012). Their samples consisted of (a) four cohorts of students who took EXPLORE in 8th grade and the ACT in 12th grade and (b) two cohorts of students in the state of Arkansas who took the Arkansas Benchmark Exams in 4th grade and EXPLORE in 8th grade. All students were categorized by their score on their respective exams into three groups: "on track" students who met the benchmark; "off track" students who missed the benchmark by one standard deviation (SD) or less, and "far off track" students who missed the benchmark by more than one SD. These studies reported two main findings. First, in 8th grade, higher percentages of African American and Hispanic students were off track or far off track for college readiness than students from other ethnic backgrounds. Second, few students who were off track moved on-track in the four years that followed. Only 37% and 46% of students who were off track in 4th grade in reading and math, respectively, were on track in 8th grade. Between 8th and 12th grade, the rates of moving on-track were only 3% (math) and 10% (reading) for far-off-track students, and 19% and 29% for off-track students.

These studies begin to explore the dynamic nature of academic readiness but face three major limitations. First, the studies only reported percentages of students who were on- or off-track. The relations between student- and school-level predictors and mobility were largely left

unexplored. Second, the data used to calculate the probability of catching up between 4th and 8th grade come from a single state, so the generalizability of the findings is low. Third, student test scores were only observed in 4th, 8th, and 12th grade, and trajectories in the four years in-between testing is unknown, limiting the actionability of the findings for schools.

The Importance of Middle School Learning Trajectories

These literatures highlight the need to monitor college readiness prior to 8th grade. As Lee (2010) asserts, "The problem with college readiness should be viewed as an issue of sustainable academic growth and transition across all levels of schooling rather than an isolated high school problem per se" (p. 827). Balfanz (2009) found, for example, that 6th grade is a critical year in which many students fall off track for high school graduation by failing a course or having too many absences. Importantly, he also found that students who triggered off-track indicators in middle schools were resilient and continued to participate in subsequent years of schooling. These findings suggest that students who struggle in the middle grades stand to benefit from intervention, and early detection is key in shaping their academic trajectories.

Recent research has examined academic achievement and achievement gaps in the middle grades but has not examined growth towards college readiness. For example, Reardon, Robinson, and Weathers (2015) used 4th/5th grade and 8th grade assessment data from the National Assessment of Educational Progress Long-Term Trend (NAEP-LTT) and ECLS-K:1998 and showed that racial/ethnic and socioeconomic achievement gaps are fairly stable across those two grade levels. Using more recent data from NWEA's MAP Growth assessments, growth trajectories in math and reading were found to be fairly similar across racial/ethnic groups throughout the middle school years (Kuhfeld, Condron, & Downey, 2019), while gender gaps in reading favoring girls appear to widen during middle school (Downey, Kuhfeld, & van

Hek, 2020). These studies provide important context for understanding inequalities in learning trajectories in middle school. However, it is equally important to understand whether these observed inequalities in middle school have down-the-line consequences for students' college readiness. Current research lacks good measures for when students in the middle grades are meeting college readiness benchmarks, and equally important, when students are falling off track relative to college readiness benchmarks.

Based on findings from the ACT studies, we might expect higher percentages of Black and Hispanic students to be consistently off-track as they move through multiple grade levels. But existing research is silent on the issue of consistency. It is also possible that students' race/ethnicity is also associated with academic mobility (e.g., the degree to which students change their relative rank-ordering over time, such as moving upwards in the distribution of test scores). Using the Early Childhood Longitudinal Study Kindergarten Cohort of 1998 (ECLS-K:1998), Quintana and Correnti (2019) found that Black and Hispanic students showed higher academic mobility between kindergarten to 8th grade than White and Asian students. Alarmingly, they found that Black students were far more likely than any other racial/ethnic to move from the top test score quartile to the lowest quartile. Given these findings, we might expect Black and Hispanic students who start on-track to be more likely to fall off track by the end of 8th grade, though extant research has not been able to directly answer such questions, likely due to limited longitudinal data on achievement within the middle school grades.

Few studies have combined the examination of academic trajectories in middle school with prediction of being ready to enter college by the end of high school. The primary exception is Lee (2012), who combined data from the Early Childhood Longitudinal Study–Birth Cohort (ECLS-B), ECLS-K:1998, and National Education Longitudinal Study of 1988 (NELS:88) to

examine achievement trajectories in math for different college pathways. College readiness benchmark scores were set based on NELS 8th, 10th, and 12th-grade math test scores that best differentiated between students who attended two-year versus four-year colleges. Lee found that for successful completion of typical four-year colleges with a bachelor's degree, students needed to perform at or above the national test "proficient" level (NAEP) in math in 8th grade, which was well above the national average. Additionally, he found that from late elementary to high school, Hispanic and Black students gradually fell behind their White and Hispanic peers in terms of being on track for four-year college entrance. However, since college readiness standards used in this study are based on students from the NELS:88 data who entered college in the early 1990s, it is unclear how generalizable these findings are to the current college admissions system.

Current Study

In summary, we have little evidence on the dynamic development of academic college readiness during the middle school grades. Some basic and important questions remain unanswered, such as (a) What fraction of students start 6th grade academically on-track? (b) What fraction of students who start 6th grade on-track are off-track at the end of 8th grade? and (c) What factors predict falling off-track? In this study, we fill these gaps by using recently-collected (2015-16 to 2017-18) math and reading test score data from over 360,000 middle school students along with a set of college readiness benchmarks (Thum & Matta, 2015) to classify students as on-track or off-track to be college ready across six time points between 6th to 8th grade. The college readiness benchmarks used in this study link MAP Growth test scores in middle school to ACT performance in high school, where an ACT score of 22 or above is considered on track for college readiness. These benchmarks are applied by MAP Growth users

to measure whether students in middle school and high school are likely on track to be college ready. This series of on-track indicators allows schools to identify and provide timely interventions to individual students. Interpreting students' achievement trajectories relative to a clear set of benchmarks facilitates conversations with students and their families about setting goals to make progress toward academic college readiness.

This dynamic approach to an early academic indicator system can be easily implemented by schools and districts. Schools will be able to monitor as students move on-track, fall off track, or sustain their status, and respond by targeting programs and services accordingly. Policymakers can also use this approach to examine trajectory patterns for subgroups of students and identify needs for improvement at the setting (e.g., school or district) level (Allensworth et al., 2018). Recent research shows that Black and Hispanic students may be more prone to downward academic mobility (Quintana & Correnti, 2019). We test this using the trajectory framework with a set of analyses that identify student- and school-level predictors for two of the possible academic trajectories: falling off track and moving on-track. In demonstrating this trajectory-based approach to gauging academic readiness for college, our goal is to provide practitioners and policymakers with an actionable way of organizing data and identifying viable points of intervention to support individual and subgroups of students.

Data

Data Sources

The student achievement data for this study come from NWEA's Growth Research Database (GRD), which contains longitudinal test scores data for students in schools across the nation. The schools and students in the GRD were not randomly sampled. Schools and districts choose to partner with NWEA and administer the MAP Growth assessments to their students for

a variety of reasons (e.g., monitor students' academic growth, teacher evaluation, placement for special programming). Thus, the students and schools that select into the GRD are not nationally representative. However, two features of GRD data provide some reassurance that the generalizability of our findings will be high. First, the GRD includes achievement data for approximately 30% of public schools serving 6th through 8th grade across the nation. Second, most schools that partner with NWEA test the majority of students within each grade (an average of 80% of enrolled students). A comparison of the school in our sample with the population of public schools serving 6th to 8th grade students is provided in Appendix Table 1.

The student and school covariates used in our analyses come from the GRD and the National Center for Education Statistics (NCES), Common Core of Data (CCD). Students' gender and race/ethnicity variables were reported by the schools prior to the MAP Growth test administrations. We use school characteristics reported in the CCD, including the percentage of Asian, Black, White, and Hispanic students, the percentage of enrolled students who are eligible for free or reduced-price lunch (FRPL), and enrollment in 6th, 7th, and 8th grades.

Sample

We follow one cohort of students who attended 6th grade in academic year 2015-16 through the end of their 8th grade year (2017-18). We start with a data set that contains over 3.6 million test events for 860,003 students across 8,349 schools. For each student, we observe up to six terms of test scores. In order to examine a full trajectory through the middle grades, we restrict the sample to students who had test scores in all of the following terms: (a) the fall of 6th grade; (b) either the fall or spring of 7th grade; and (c) the spring of 8th grade. This sample contains 363,685 students across 49 states and Washington DC. The sample is 49% female, 54%

White, 14% Black, 17% Hispanic, and 4% Asian, which is slightly more female, more White, more Asian, less Black, and less Hispanic than the full data set (see Appendix Table 2).

About 72% of the students in our sample attended only one school from the fall of 6th grade to the spring of 8th grade; 26% attended two schools. Students may have changed schools due to family reasons or to transition from a school that only serves up to grade 6 or grade 7 to another school that serves upper grades. We generate indicators for students' having changed schools during transition from 6th to 7th grade ("SchoolChange6" = 1 for 22% of students) and during transition from 7th to 8th grade ("SchoolChange7" = 1 for 5% of students) and use these indicators to control for school mobility in our analyses. For the purpose of analyses that leverage school-level characteristics, students are assigned to the school at which they tested the most. About 29% of the "modal" schools for students in the sample only served grades 6 to 8; another 5% of the schools served only grades 7 and 8; the rest served other combinations of grade levels, such as K-8 or 5-8. In the remainder of this paper, we use the term "middle school" to refer generally to schooling between 6th and 8th grade, regardless of the actual grades served by the school.

Measures

Test scores. We use students' scores on the MAP Growth mathematics and reading assessments to determine if students were on track for college readiness. MAP Growth is a computer adaptive test—which means measurement is precise even for students above or below grade level—and is vertically scaled to allow for the estimation of gains across time. Each test takes approximately 40 to 60 to administer and typically takes place three times per academic year—in the fall, winter, and spring. The assessments are aligned to content standards within

each state. Test scores are reported on the RIT (Rasch Unit) scale, where RIT is a linear transformation of the logit scale units of the Rasch item response theory model.

Benchmarks. The benchmarks we use to classify math and reading test scores in each grade and test term (i.e., fall or spring) as on- or off-track for college readiness come from Thum and Matta (2015). These benchmarks anchor on the ACT score of 22[1] for math and reading, the minimum ACT scores required to "have at least a 50% chance of earning a B or higher grade and approximately a 75-80% chance of earning a C or higher grade in the corresponding college course or courses" (Allen & Radunzel, 2017). ACT scores are a widely accepted barometer for college readiness. Projections of an acceptable college and career ready ACT score and pre-requisites that are considered college ready are used to allow students access to college preparatory programs such as Advanced Placement and dual enrollment courses. Further, 15 states currently use ACT scores as a measure of college and career readiness for accountability metrics under ESSA (Achieve, 2016).

The MAP benchmarks were created using a sample of over 620,000 test events for 83,318 students in 4th to 12th grade in 410 schools across the country. Scoring above the MAP benchmark in a test term represents being on a projected growth trajectory for scoring a 22 or above on the ACT in high school. Referenced against NWEA's national MAP Growth norms (Thum & Hauser, 2015), the benchmarks imply that students who scored at or above the 61st to 76th percentiles in math or between the 59th to 69th percentiles in reading were likely to be on track for college readiness. The benchmarks were estimated through a multivariate growth model that simultaneously modeled MAP Growth trajectories and ACT scores while accounting the self-selection in taking the ACT in high school. Accounting for potential self-selection biases allow the benchmarks to be generally applicable to all middle school students, not just ones who

are very likely to take the ACT in high school. Thum and Matta (2015) found that about 67 to 75 students out of 100 who met or exceeded the benchmarks were correctly classified as college ready and only 13 to 20 students of 100 of those students who were not on track were misclassified.

We focus on MAP Growth ACT benchmarks because they are being applied by schools and districts across the country to track students' progress towards college readiness. State and districts have also utilized these benchmarks for accountability and goalsetting purposes. For instance, one medium district in Illinois sets the goal for middle school and elementary schools that feed into their high schools to attain the college ready MAP benchmark prior to entering high school (School District 86, 2018). The state of Colorado uses MAP Growth ACT benchmarks to set standards for college readiness which schools are held accountable for fulfilling college readiness requirements (Colorado Department of Education, 2019). However, as we discuss in the limitation section, this set of benchmarks seek to capture one aspect of college readiness and are not deterministic of students' eventual college enrollment and success.

On-track indicators. Using the MAP benchmarks described above, we assign a binary indicator to students that specify whether they are on- or off- track for college readiness in a specific grade and term. For example, students who scored 225.30 RIT or higher on their math assessment in the fall of 6^{th} grade are classified as on-track (1), while students scoring 225.29 RIT or lower are classified as off-track (0). Thus, in each subject, each student is assigned a value of 1 or 0 on up to six indicators for the fall and spring of 6^{th} through 8^{th} grade. Online Appendix Table 3 shows the benchmarks and percentage of students who met the benchmarks at each test term. If a student did not take an assessment during a test term, her on-track indicator for that term would be missing.

Analysis

Trajectory groups

Since students are either on-track or off-track in each of the six terms, there is a total of $2^6 = 64$ unique trajectories. For example, students could be on-track at all six timepoints, on-track for the first five timepoints but not the sixth, on-track at all but the second timepoint, and so on. We examined all 64 patterns to see the frequency of each pattern and look for common trends among the groups. There does not appear to be a large amount of switching between on-track/off-track status during the middle school grades, and so we collapse most of the groups into smaller subsets. In the end, we organize student trajectories in each subject into six groups: three who start on-track and three who start off-track.

(a) "always on-track": students who were consistently on-track for college readiness throughout all the terms in which test scores are observed;

(b) "inconsistently on-track": students who were on-track in the fall of 6th grade and the spring of 8th grade, but off-track during at least one term in between;

(c) "fell off track": students who were on-track in the fall of 6th grade but off-track in the spring of 8th grade;

(d) "always off-track": students who were consistently off-track for college readiness throughout all the terms in which test scores are observed;

(e) "inconsistently off-track": students who were off-track in the fall of 6th grade and the spring of 8th grade, but on-track during at least one term in between;

(f) "moved on-track": students who were off-track in the fall of 6th grade but on-track in the spring of 8th grade.

For the remainder of this paper, we refer to these six classifications as "trajectory groups." Organizing trajectories into these six groups allows us to focus on three phenomena of interest (i.e., starting status, change in status, and end status) with no substantive loss of data.

For students in each trajectory group, we present student-level summary statistics, including gender, race/ethnicity, indicators for having changed schools between 6th and 7th grade and between 7th and 8th grade, and RIT score in the fall of 6th grade. To illustrate the academic growth patterns of these trajectory groups, we plot the mean RIT scores for each group across the six middle school test terms.

Predicting Status Change

To test if demographic characteristics are associated with academic mobility, we employ two restricted samples. First, we focus on the subset of students who were on-track in the fall of 6th grade and predict falling off track by the spring of 8th grade. For a student *i* in school *j,* we generate an indicator for having changed status (y_{ij}: 1=finished 8th grade off-track, 0=finished 8th grade on-track) and use this binary variable as the outcome. Then, we focus on students who were off-track in the fall of 6th grade and generate the same indicator for having changed status (y_{ij}: 1=finished 8th grade on-track, 0=finished 8th grade off-track).

To identify student and school characteristics that predict either falling off track or moving on-track, we estimate a series of hierarchical generalized linear models (HGLM), where students' on/off track status indicators are nested within schools. In the notation below, we focus on the falling off track case. Let the level-1 outcome y_{ij} take a value of 1 with conditional probability p_{ij}. The null HGLM without predictors (Model I) estimates the log odds of falling off track as

$$\ln\left[\frac{p_{ij}}{1-p_{ij}}\right] = \gamma_{00} + u_{0j} \qquad (1)$$

In this model, γ_{00} is the grand-mean log odds of falling off track and u_{0j} is the school-level random effect that captures between-school variation in the odds of falling off track by the end of 8th grade. Model II builds on Model I and includes student-level covariates: Male, Black, Hispanic, Asian, having changed schools between 6th and 7th grade, having changed schools between 7th and 8th grade, and grand-mean-centered initial RIT score in the fall of 6th grade.

$$\ln\left[\frac{p_{ij}}{1-p_{ij}}\right] = \gamma_{00} + \gamma_{10}\text{Male}_{ij} + \gamma_{20}\text{Black}_{ij} + \gamma_{30}\text{Hispanic}_{ij} + \gamma_{40}\text{Asian}_{ij} + \gamma_{50}\text{SchoolChange6}_{ij} + \gamma_{60}\text{SchoolChange7}_{ij} + \gamma_{70}\text{InitialRIT}_{ij} + u_{0j} \quad (2)$$

Model III additionally includes a set of school-level covariates: (a) percentage of students eligible for FRPL, (b) percentage of students who are Black, (c) percentage of students who are Hispanic, and (d) percentage of students who are Asian.

$$\begin{aligned}\ln\left[\frac{p_{ij}}{1-p_{ij}}\right] = {} & \gamma_{00} + \gamma_{01}\%\text{FRPL}_j + \gamma_{02}\%\text{Black}_\text{j} + \gamma_{03}\%\text{Hispanic}_\text{j} \\ & + \gamma_{04}\%Asian_\text{j} + \gamma_{10}\text{Male}_{ij} + \gamma_{20}\text{Black}_{ij} + \gamma_{30}\text{Hispanic}_{ij} \\ & + \gamma_{40}\text{Asian}_{ij} + \gamma_{50}\text{SchoolChange6}_{ij} + \gamma_{60}\text{SchoolChange7}_{ij} \\ & + \gamma_{70}\text{InitialRIT}_{ij} + u_{0j}\end{aligned}$$

Main Findings

Trajectory Groups

Table 1 presents the percentage of students within each trajectory group. In math, the majority (73%) of students did not change status between 6th and 8th grade. Specifically, 54% of students were always off-track to be college ready in math throughout middle school while 19% of students were always on-track. Only 15% of students switched status between the start and end of middle school, with 4% of students falling off track and 11% of students moving on-track. The remaining 12% of students were inconsistently on-track or off-track throughout middle

school. In reading, there was somewhat more mobility in students' trajectories. Thirty-five percent of students were always off-track for college readiness with regards to their reading skills, while 25% were always on-track. Twenty percent of students were inconsistently on- or off-track in reading, while the remaining 20% changed status (11% falling off and 9% moving on track).

Figure 1 shows the average RIT score trajectories for students within each group between the fall of 6th grade through the spring of 8th grade. The black horizontal bars display the college readiness benchmark within each grade/term. In math, the groups that change status (either move on-track or fall off track) appear to be changing status during 7th grade on average. In addition, the always on-track and always off-track groups in math are spreading further apart during each grade, so that the already large gap between the two groups at the start of middle school (1.88 SDs) is even larger by the end of 8th grade (2.02 SDs). In reading, the groups who are moving on-track or falling off track look very similar between the spring of 6th grade through the fall of 8th grade, whereas the always on-track and always off-track groups are fairly spread out (a gap of approximately 2 SDs). Trajectories by gender and race/ethnicity are illustrated in Appendix Figures 1 and 2.

Figure 2 shows the percentage of students within each trajectory group by gender and race/ethnicity. There does not appear to be significant gender differences in the distribution of students in each trajectory group within math, though male students are more likely to be always off-track in reading than female students. However, there are clear patterns by racial/ethnic group. Black and Hispanic students are far more likely to be always off-track in both math and reading than White and Asian students. Specifically, 77% of Black students are always off-track in math, relative to 69% of Hispanic students, 44% of White students, and 28% of Asian

students. Similarly, only 5% of Black students are always on track in math, compared with 43% of Asian students and 24% of White students. The patterns in reading are quite similar, with over half of Black (54%) and Hispanic (51%) of students always off track, relative to 26% of White students and 18% of Asian students.

The two groups of students who were always on-track and students who were always off-track also differed in terms of the demographic composition of the schools they attended (see Table 1). The average always on-track student attended schools that were more affluent and had lower percentages of Black, Hispanic, or Asian students than the always off-track students. For example, students who are always on-track in math are in schools with an average of 33% of its student body eligible for FRPL and 33% Black, Hispanic, or Asian students, compared with the always off-track students who are in schools with 56% of its student body eligible for FRPL and 49% Black, Hispanic, or Asian students.

Predicting Status Change

Table 2 presents the associations between demographic characteristics and status change (i.e., falling off track or moving on-track). The dependent variable is an indicator for status change, and the coefficients are presented as odds ratios. Coefficients larger than 1 represent higher odds; coefficients smaller than 1 represent lower odds. We begin by looking at the model predicting falling off track in math among the subset of the sample (28%) that was initially on track in the fall of 6th grade. Panel A shows the odds that students who were on-track at the beginning of 6th grade fell off track (i.e., off-track in the spring of 8th grade). Column (1) shows the results from the null model with no predictors. The odds-ratio for falling off track is 0.202, which translates into a predicted probability of 16.8%. Column (2) shows the associations between student-level covariates and falling off track, where White female students who did not

change schools during the study period are the omitted category. Being male, Black, Hispanic, or a member of another race/ethnicity group is associated with significantly higher odds of falling off track in math (odds ratios of 1.381, 1.398, 1.171, and 1.139, respectively). Changing schools between grades is also associated with higher odds of falling off track (odds ratios of 1.352 and 1.665). Being Asian and having higher initial achievement are associated with lower odds of falling off track. Column (3) shows the findings from a model that additionally includes school-level predictors: the percentage of students eligible for FRPL and the percentages of students who are Black, Hispanic, and Asian. The percentage of FRPL-eligible students in the school is significantly associated with higher odds of falling off track. The percentage of Hispanic students and the percentage of Asian students in the school are associated with significantly lower odds of falling off track. The estimate for the percentage of Black students in the school also suggests lower odds of falling off track, but it is not significant.

Panel B shows the odds ratios for students who were off-track in the fall of 6th grade to move on-track. Estimates are the opposite direction as those presented in Panel A. Being male, Black, Hispanic, and changing schools between grades were associated with significantly lower odds of moving on-track. Being Asian and having higher initial achievement were associated with higher odds of moving on-track. The percentage of FRPL-eligible students in the school is associated with lower odds of moving on-track. In contrast, the percentages of Black, Hispanic, and Asian students in the school are associated with higher odds of moving on-track.

Panels C and D show the findings for changing status in reading. The estimates are slightly different in magnitude compared to the math results, but the findings are qualitatively similar. Being Male, Black, or Hispanic, changing schools between grades, and attending a school with a higher percentage of FRPL-eligible students are associated with higher odds of

falling off track and lower odds of moving on-track. The opposite is true for being Asian, having higher initial achievement, and attending a school with higher percentages of Black, Hispanic, and Asian students.

Discussion

Leveraging a unique large data set, this study presents novel evidence on academic trajectories and demonstrates an approach for monitoring college readiness in middle school. We report three main findings. First, on-track for college readiness status remains stable for most students throughout middle school. Second, students who are always on-track differ from students who are always off-track in terms of individual characteristics and in terms of their schools' demographics. Third, individual and school characteristics significantly predict changing status (i.e., moving on-track or falling off track).

Students' trajectories are relatively stable from the fall of 6th grade to the spring of 8th grade. About 73% of our sample maintained the same status (19% were always on-track; 54% were always off-track). Another 12% of the sample fluctuated in the middle terms but finished middle school with the same status as they started. This is not surprising, as previous research demonstrated student trajectories are stable over time (Reardon et al., 2015). However, this finding also highlights the need for intervention, both in elementary and middle school, to help students move on-track and stay on-track. To increase postsecondary access and attainment, policy needs to focus upstream. It is imperative to increase the fraction of the student population entering middle school with the prerequisite foundation to be college ready at the end of 8th grade.

Participation in college preparatory and early college programs hinges on academic preparedness at high school entry. As extant research has demonstrated, the recent overall

expansion of programs such as DE and AP has not reduced the racial and SES gaps in participation (Xu et al., 2019). Simply increasing the general coverage of college preparatory or college-level courses does not resolve the underlying racial/ethnic and socioeconomic gaps in 8th grade achievement that results in gaps in access to those advanced courses. The enduring gap in access to advanced coursework can partly be explained by the strong relationship we find between student and school demographics and academic trajectories in middle school.

A large fraction of "always on-track" students are White or Asian and attend a school with relatively low percentages of FRPL-eligible students. In contrast, a large fraction of "always off-track" students are Black or Hispanic and attend a school with relatively high percentages of FRPL-eligible students. The predictive power of race/ethnicity and SES also applies to positive and negative change in on-track status. Among students who start with the same status (e.g., on-track in the fall of 6th grade), individual and school demographics are strongly associated with changing status. Specifically, being male, Black, Hispanic or Other Race and attending a school with higher percentage of students who are eligible for FRPL are associated with lower odds of moving on-track and higher odds of falling off-track. In other words, the odds are working against students from disadvantaged backgrounds throughout the middle grades: students who are already behind tend to stay behind; students who are on-track tend to fall behind.

To the extent that college preparation opportunities are allocated by on-track status in 8th grade, middle school presents the last chance for students to become ready and eligible. Since students from disadvantaged backgrounds are more likely to start the middle grades off-track or fall off track during the middle grades, schools need to vigilantly monitor their achievement within and across grades. Programmatic interventions should shift from general expansion of college preparatory curriculum to a focus on implementation. Specifically, support services

should be offered to boys and Black and Hispanic students, especially those who are on the margin of college readiness (i.e., within a few points of moving on-track or falling off-track).

For the purpose of identifying students in need of support, data from annual state standardized tests are both untimely and inadequate. To ensure timely provision of instructional intervention, individual student performance should be measured regularly and consistently relative to a set of benchmarks. To monitor student progress toward college readiness, schools can additionally adopt a set of benchmarks, such as the ones created by Thum & Matta (2015). As this study demonstrates, analyzing students' academic achievement relative to on-track benchmarks requires very little computation, and the interpretation of results is straight-forward. Schools and districts can easily implement this approach to tracking students' progress and readiness.

Limitations

This study has a few limitations that merit cautious interpretation of its findings. First, our analyses are descriptive, and the estimates should not be taken as causal links. Second, our unique large sample includes students from across the nation but may not be representative of the nation. Third, in constructing a sample using only students who had at least one test score in each grade between 6^{th} and 8^{th}, we likely excluded students with the highest mobility from the analyses. Therefore, we may be underestimating the percentage of students who are always off-track. In addition, we do not observe other student-level characteristics that may predict academic trajectories, such as eligibility for FRPL, English Learner status, and eligibility to receive Special Education services.

Finally, we acknowledge that the definition of college readiness used by the ACT (i.e., having a 50% chance of earning a B in an introductory course) is limited in scope and nuance.

We considered using MAP Growth SAT benchmarks but ultimately chose ACT benchmarks because (a) SAT benchmarks were only available for total scores pooling math and English and (b) ACT cut scores for college readiness are widely used by researchers and practitioners. The models used to create the ACT benchmarks rest on probabilistic and not deterministic interpretations. Our intention is not to establish a single cut score as the ultimate standard for college readiness. Schools should not rely on standardized test scores as the sole indicator, and we certainly do not advocate using benchmarks to group and label students for the purpose of academic tracking. Extant research recommends using multiple indicators to evaluate college readiness, including course grades and attendance (Allensworth et al., 2014). Students' socioemotional wellbeing and behavior are important factors that contribute to their ability to learn and thrive as young adults but are outside the scope of this paper (Gaertner, 2015; Kieffer 2014; Mattern, Allen, & Camara, 2016). College success depends on a variety of factors; academic achievement in the middle grade is (only) one important predictor. Our goal was to describe a framework using which researchers and policymakers can identify students in need of additional support, as well as viable points for effective intervention.

Conclusion

This study makes three key contributions to the literature on academic achievement and college readiness. First, we illustrate academic growth trajectories from the fall of 6th grade to the spring of 8th grade for the pooled sample and for student subgroups by gender and ethnicity. We report details about academic growth and growth gaps unfound in previous research.

Second, we demonstrate an actionable approach for tracking student progress in the middle grades. The nascent literature highlights the importance of being college-ready by the end of 8th grade but does not offer any tangible methods to monitor readiness throughout middle

schools. We generate an actionable indicator by applying benchmarks that districts currently use to monitor college readiness.

Finally, using multilevel models that significantly improve upon prior studies, we report the associations between being on-track for college readiness and student- and school-level characteristics. In addition, we identify predictors for changing college readiness during the middle grades (i.e., falling off track or moving on-track). Whereas previous studies only examine indicators of college readiness as a static measure at a couple of points in time, we add to the literature new knowledge on the dynamic development of college readiness.

In this study, we use a set of college readiness benchmarks to classify students as either on-track (at or above the benchmark) or off-track (below the benchmark) at each timepoint. However, this is not the only way that one could establish college readiness trajectories. In an ideal world, we would be able to follow each student longitudinally until after high school to establish the score trajectories that were associated with two- or four-year college enrollment. Given our students recently completed middle school, we lack those long-term outcomes for this cohort, but future research could aim to follow up with these students to study their postsecondary outcomes. Additionally, instead of using observed cut scores such as NWEA's college readiness benchmarks (Thum & Matta, 2015), remaining on-track or falling off track for college could be treated as an unobserved characteristic of students that could be estimated from students' academic trajectories. For instance, growth mixture modeling assumes that there are unobserved sub-population of individuals (such as students who are on and off track for college readiness) that show different growth trajectories over time (Ram & Grimm, 2009). We are unaware of any studies using such an approach to detect latent classes of likely to be college-

ready students based on their math and reading score trajectories, but additional research could compare these latent modeling approaches with our benchmarking approach.

Notes

[1] Thum and Matta (2015) presented two sets of MAP Growth benchmarks, for ACT scores of 22 and 24, respectively. We use the benchmarks for ACT scores of 22, following Allen and Radunzel (2017).

References

Achieve. (2016). *High school assessments and accountability during ESSA transition*. Washington, D.C.

ACT. (2008). *The forgotten middle: Ensuring that all students are on target for college and career readiness before high school*. Iowa City, IA: ACT.

ACT. (2012). *Catching up to college and career readiness*. Austin, TX: ACT.

Allen, J. & Radunzel, J. (2017). What are the ACT college readiness benchmarks? *ACT Research & Policy*, October 2017. Iowa City, IA: ACT.

Allensworth, E. (2013). The use of ninth-grade early warning indicators to improve Chicago schools. *Journal of Education for Students Placed At Risk, 18*, 68–83. doi: 10.1080/10824669.2013.745181

Allensworth, E. M., & Easton, J. Q. (2005). *The on-track indicator as a predictor of high school graduation*. Chicago, IL: Consortium on Chicago School Research, University of Chicago. Retrieved from http://ccsr.uchicago.edu/sites/default/files/publications/p78.pdf.

Allensworth, E. M., Gwynne, J. A., Moore, P., & de la Torre, M. (2014). *Looking forward to high school and college: Middle grade indicators of readiness in Chicago Public Schools*. Chicago, IL: The University of Chicago Consortium on Chicago School Research.

Allensworth, E. M., Nagaoka, J., & Johnson, D. W. (2018). *High school graduation and college readiness indicator systems: What we know, what we need to know*. Chicago, IL: University of Chicago Consortium on School Research.

Balfanz, R. (2009). *Putting middle grades students on the graduation path*. Westerville, OH: National Middle School Association.

Balfanz, R., Herzog, L., & Mac Iver, D. (2007). Preventing student disengagement and keeping students on the graduation path in urban middle-grades schools: Early identification and effective interventions. *Educational Psychologist, 42*, 223–235. doi: 10.1080/00461520701621079

Cassidy, L., Keating, K., & Young, V. (2010). *Dual enrollment: Lessons learned on school-level implementation*. Menlo Park, CA: SRI International.

Colorado Department of Education. (2019). Assessment instrument description: NWEA Colorado academic standards-aligned MAP Growth. Retrieved from http:// www.cde.state.co.us/accountability/nwea_assessment_instrument_description_072319

Dougherty, C. (2014). Catching up to college and career readiness: The challenge is greater for at-risk students. *ACT Research & Policy, May 2014*. Iowa City, IA: ACT.

Dougherty, C. & Fleming, S. (2012). *Getting students on track to college and career readiness: How many catch up from far behind?* Iowa City, IA: ACT.

Downey, D., Kuhfeld, M., & van Hek, M. (2020). Do schools favor girls? Gender gaps in cognitive skills. Paper presented at the 2020 Annual Meeting of the American Sociological Society.

ESSA (2015). Every Student Succeeds Act of 2015, Pub. L. No. 114-95 § 114 Stat. 1177 (2015-2016).

Gaertner, M. N. & McClarty, K. L. (2015). Performance, perseverance, and the full picture of college readiness. *Educational Measurement: Issues and Practice*, *34*(2), 20-33.

Hegedus, A. (2018). *Evaluating the relationships between poverty and school performance*. Retrieved from https://www.nwea.org/research/publication/evaluating-the-relationships-between-poverty-and-school-performance-whitepaper/

Kieffer, M. J, (2014). Navigating into, through, and beyond the middle grades: The role of middle grades attendance in staying on track for high school graduation. *Journal of School Psychology, 52,* 549-565.

Kless, L., Soland, J., & Santiago, M. (2013). Analyzing evidence of college readiness: A tri-level empirical and conceptual framework. Stanford, CA: John W. Gardner Center for Youth and Their Communities.

Klopfenstein, K., & Thomas, M. K. (2009). The link between advanced placement experience and early college success. *Southern Economic Journal, 75*(3), 873–991. Retrieved from https://jstor.org/stable/27751419

Kolluri, S. (2018). Advanced Placement: The Dual Challenge of Equal Access and Effectiveness. *Review of Educational Research, 88*(5), 671–711. doi: 10.3102/0034654318787268

Kuhfeld, M., Condron, D., & Downey, D. (2019). When does inequality grow? A seasonal analysis of racial/ethnic disparities in learning in kindergarten through eighth grade. *The Collaborative for Student Growth at NWEA Working Paper*. Portland, OR: NWEA.

Lee, J. (2010). Tripartite growth trajectories of reading and math achievement: Tracking national academic progress at primary, middle and high school levels. *American Educational Research Journal, 47*(4), 800-832.

Lee, J. (2012). College for all: Gaps between desirable and actual P-12 math achievement trajectories for college readiness. *Educational Researcher, 41*(2), 43-55.

Mattern, K., Allen, J., & Camara, W. (2016). Thoughts on a multidimensional middle school index of college readiness. *Educational Measurement: Issues and Practice, 35*(3), 30-34.

Museus, S. D., Lutovsky, B. R., & Colbeck, C. L. (2007). Access and equity in dual enrollment programs: Implications for policy formation. Higher Education in Review, 4, 1-19.

Quintana, R. & Correnti, R. (2019). The concept of academic mobility: Normative and methodological considerations. *American Educational Research Journal.* DOI: 10.3102/0002831219876935

Ram, N. & Grimm, K. (2009). Methods and measures: Growth mixture modeling: A method for identifying differences in longitudinal change among unobserved groups. *International Journal of Behavioral Development, 33*(6): 565–576. doi:10.1177/0165025409343765

Reardon, S.F. (2019). Educational opportunity in early and middle childhood: Using full population administrative data to study variation by place and age. *RSF: The Russell Sage Foundation Journal of the Social Science,* 5(2), 40-68. Retrieved from https://cepa.stanford.edu/content/educational-opportunity-early-and-middle-childhood-using-full-population-administrative-data-study-variation-place-and-age

Reardon, S. F., Robinson, J. P., & Weathers, E. S. (2015). Patterns and trends in racial/ethnic and socioeconomic academic achievement gaps. In H.A. Ladd & E. B. Fiske (Eds.), *Handbook of Research in Education Finance and Policy, 2nd ed.* (pp. 497–516). Mahwah NJ: Erlbaum.

Rowland Woods, J. (2018). *50-State Comparison: States' School Accountability Systems*. Education Commission of the States. Retrieved from https://www.ecs.org/50-state-comparison-states-school-accountability-systems/

Royster, P., Gross, J., & Hochbein, C. (2015). Timing is Everything: Getting Students Back on Track to College Readiness in High School. *The High School Journal*, *98*(3), 208–225. doi: 10.1353/hsj.2015.0005

School District 86. (2018). Clarifying and correcting District 86 high school readiness information. Retrieved from https://d86.hinsdale86.org/site/handlers/filedownload.ashx?

moduleinstanceid=2787&dataid=4410&FileName=Correction%20Slides_Final_2018-04-09.pdf

Song, M., & Zeiser, K. (2019). *Early college, continued success: Longer-term impact of early college high schools*. Washington, D.C.: American Institute for Research.

Thum Y. M., & Hauser, C. H. (2015). NWEA 2015 MAP Norms for Student and School Achievement Status and Growth. *NWEA Research Report*. Portland, OR: NWEA

Thum, Y. M. & Matta, T. (2015). MAP college readiness benchmarks: A research brief. *NWEA Research Report*. Portland OR: NWEA.

Xu, D., Fink, J., & Solanki, S. (2019). College Acceleration for All? Mapping Racial/Ethnic Gaps in Advanced Placement and Dual Enrollment Participation. *Community College Research Center Working Paper, No.* (13). Retrieved from https://files.eric.ed.gov/fulltext/ED598955.pdf

Figure 1. Achievement Growth by Trajectory Group

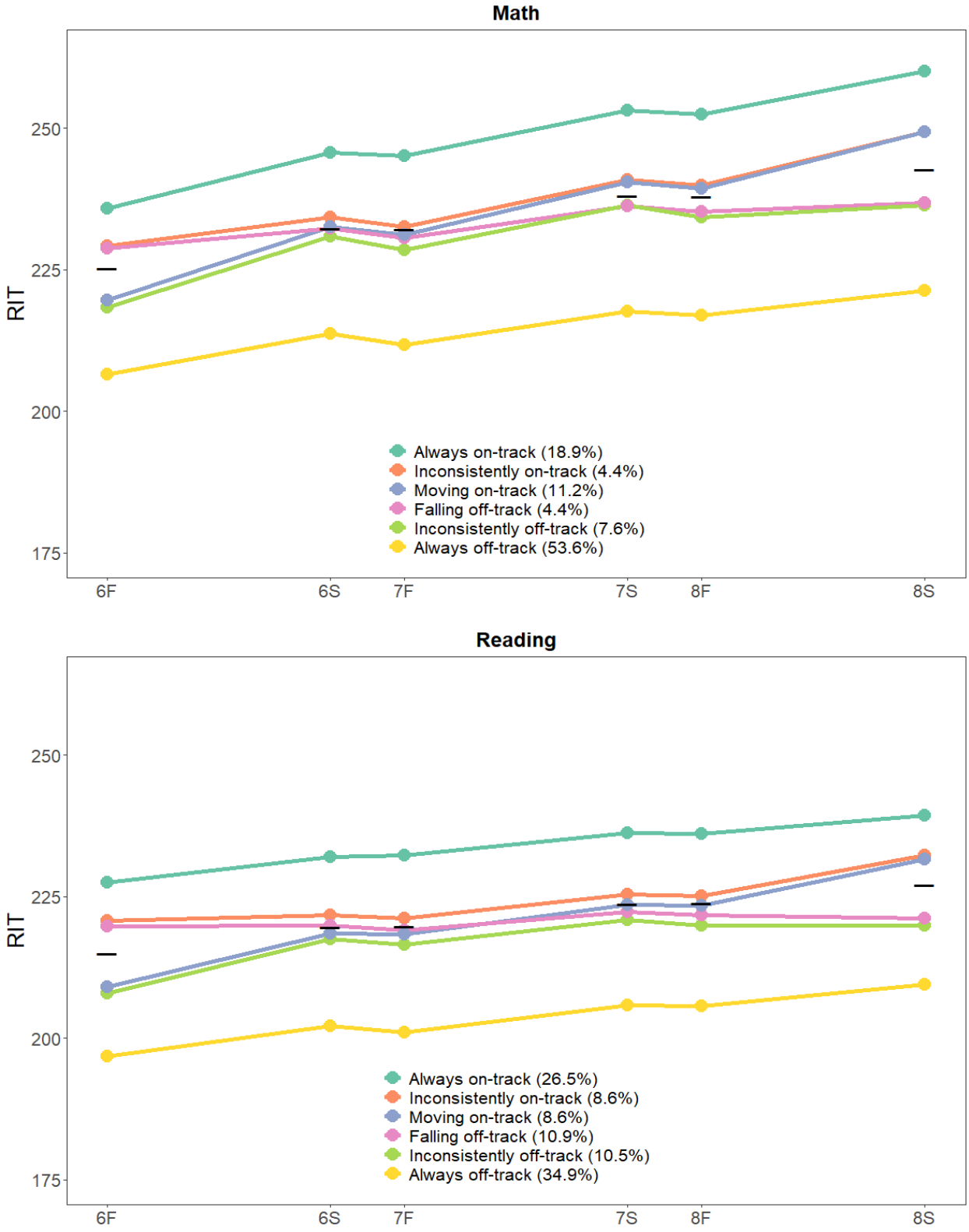


Figure 2. Trajectory Group Distribution by Gender and Race/Ethnicity

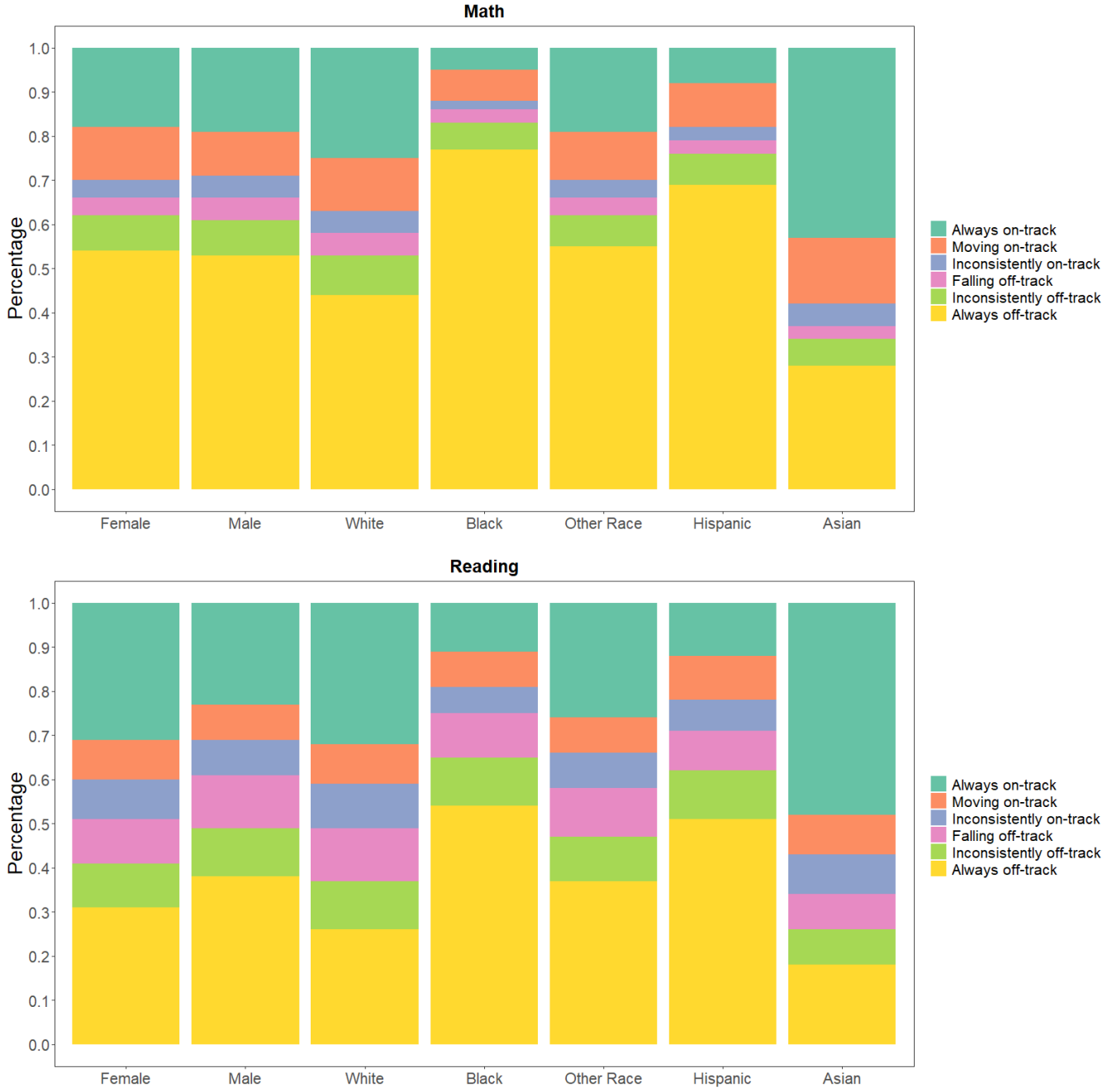


Table 1. Summary Statistics by Trajectory Group, Math

	Full Sample	(1) always on-track	(2) always off-track	(3) on-track fall 6th, off, on spring 8th	(4) off-track fall 6th, on, off spring 8th	(5) on-track fall 6th, off spring 8th	(6) off-track fall 6th, on spring 8th
				Math			
N	363,686	68,569	194,867	16,074	27,751	15,865	40,560
% of Sample	100%	19%	54%	4%	8%	4%	11%
Gender	0.51	0.54	0.50	0.53	0.50	0.57	0.46
White	0.53	0.69	0.44	0.66	0.60	0.65	0.60
Black	0.14	0.04	0.20	0.07	0.11	0.09	0.09
Hispanic	0.17	0.07	0.22	0.11	0.15	0.12	0.15
Asian	0.04	0.09	0.02	0.04	0.03	0.02	0.05
Other Race	0.11	0.11	0.12	0.11	0.11	0.12	0.11
Initial RIT	216.43	235.85	206.58	229.25	218.42	228.72	219.66
Moving 6th-7th Grade	0.22	0.22	0.22	0.21	0.25	0.25	0.20
Moving 7th-8th Grade	0.05	0.03	0.06	0.04	0.05	0.05	0.04
% FRPL	0.48	0.33	0.56	0.39	0.45	0.42	0.44
% White	0.57	0.67	0.51	0.65	0.61	0.65	0.61
% Black	0.15	0.09	0.19	0.11	0.13	0.11	0.12
% Hispanic	0.19	0.14	0.22	0.15	0.18	0.15	0.19
% Asian	0.04	0.06	0.03	0.04	0.04	0.04	0.04
District SES	0.08	0.54	-0.16	0.35	0.17	0.32	0.18
District %ELL	0.08	0.06	0.09	0.06	0.07	0.06	0.07
District %Poverty	0.13	0.10	0.14	0.11	0.12	0.11	0.12
District Gini Index	0.37	0.36	0.38	0.36	0.37	0.36	0.37

Table 1. Student Summary Statistics by Trajectory Group, Reading

	Full Sample	(1) always on-track	(2) always off-track	(3) on-track fall 6th, off, on spring 8th	(4) off-track fall 6th, on, off spring 8th	(5) on-track fall 6th, off spring 8th	(6) off-track fall 6th, on spring 8th
				Reading			
N	363,959	96,336	127,066	31,312	38,231	39,752	31,262
% of Sample	100%	25%	35%	9%	11%	11%	9%
Gender	0.51	0.45	0.56	0.48	0.52	0.54	0.46
White	0.54	0.67	0.40	0.61	0.54	0.60	0.53
Black	0.14	0.06	0.22	0.11	0.15	0.12	0.13
Hispanic	0.17	0.09	0.25	0.13	0.17	0.13	0.19
Asian	0.04	0.07	0.02	0.04	0.03	0.03	0.04
Other Race	0.11	0.11	0.12	0.11	0.11	0.12	0.11
Initial RIT	211.71	227.46	196.82	220.70	207.94	219.80	209.01
Moving 6th-7th Grade	0.22	0.21	0.23	0.22	0.22	0.23	0.20
Moving 7th-8th Grade	0.05	0.04	0.07	0.04	0.05	0.05	0.05
% FRPL	0.48	0.36	0.58	0.43	0.48	0.44	0.49
% White	0.57	0.65	0.49	0.62	0.58	0.62	0.57
% Black	0.15	0.11	0.20	0.13	0.15	0.13	0.15
% Hispanic	0.19	0.14	0.24	0.17	0.19	0.17	0.21
% Asian	0.04	0.05	0.03	0.04	0.04	0.04	0.04
District SES	0.10	0.46	-0.24	0.24	0.08	0.22	0.05
District %ELL	0.08	0.07	0.09	0.07	0.08	0.07	0.08
District %Poverty	0.13	0.10	0.15	0.12	0.13	0.12	0.13
District Gini Index	0.37	0.36	0.38	0.37	0.37	0.37	0.37

Table 2. HLM Estimates for Predicting Changing Status (Fell off Track or Moved On-Track)

	Math						Reading					
	Panel A: Changed Status: Fell Off Track			Panel B: Changed Status: Moved On-Track			Panel C: Changed Status: Fell Off Track			Panel D: Changed Status: Moved On-Track		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Intercept	0.202***	0.061***	0.062***	0.148***	0.056***	0.057***	0.342***	0.147***	0.148***	0.180***	0.128***	0.130***
	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
Male		1.381***	1.380***		0.856***	0.856***		1.502***	1.504***		0.804***	0.804***
		(0.028)	(0.028)		(0.011)	(0.011)		(0.020)	(0.020)		(0.011)	(0.011)
Black		1.398***	1.365***		0.646***	0.610***		1.527***	1.534***		0.669***	0.620***
		(0.061)	(0.064)		(0.017)	(0.017)		(0.039)	(0.043)		(0.017)	(0.017)
Hispanic		1.171***	1.202***		0.828***	0.787***		1.144***	1.184***		0.865***	0.802***
		(0.044)	(0.048)		(0.020)	(0.019)		(0.028)	(0.030)		(0.019)	(0.019)
Asian		0.465***	0.484***		1.896***	1.825***		0.590***	0.612***		1.479***	1.395***
		(0.030)	(0.032)		(0.072)	(0.070)		(0.022)	(0.024)		(0.058)	(0.056)
Other Race		1.137***	1.136***		0.848***	0.839***		1.119***	1.122***		0.838***	0.823***
		(0.047)	(0.047)		(0.024)	(0.024)		(0.030)	(0.030)		(0.024)	(0.023)
School Change 6-7th grade		1.350***	1.332***		0.769***	0.788***		1.238***	1.223***		0.851***	0.867***
		(0.055)	(0.053)		(0.025)	(0.025)		(0.031)	(0.030)		(0.021)	(0.021)
School Change 7-8th grade		1.664***	1.633***		0.723***	0.724***		1.349***	1.335***		0.866***	0.871***
		(0.099)	(0.098)		(0.031)	(0.031)		(0.050)	(0.050)		(0.030)	(0.030)
Initial RIT		0.768***	0.769***		1.248***	1.248***		0.816***	0.817***		1.143***	1.143***
		(0.002)	(0.002)		(0.002)	(0.002)		(0.001)	(0.001)		(0.002)	(0.002)
School % FRPL			1.836***			0.635***			1.445***			0.624***
			(0.177)			(0.055)			(0.082)			(0.037)
School % Black			0.852			1.888***			0.819***			1.721***
			(0.092)			(0.177)			(0.055)			(0.113)
School % Hispanic			0.586***			1.976***			0.674***			1.798***
			(0.063)			(0.180)			(0.043)			(0.113)
School % Asian			0.437***			2.200***			0.616***			1.682***
			(0.121)			(0.507)			(0.114)			(0.282)
Students	100425	100425	100425	262771	262771	262771	167240	167240	167240	196238	196238	196238
Schools	4038	4038	4038	5689	5689	5689	4672	4672	4672	5415	5415	5415
Intercept-Variance	0.665	0.643	0.618	0.711	0.798	0.777	0.287	0.224	0.214	0.308	0.258	0.248

Odds ratio robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Samples for Panels A and C include students who were on-track in fall of 6th grade. Samples for Panels B and D include students off-track in fall of 6th grade. Dependent variables are binary (changed=1). Columns (1)-(3) correspond to models (1)-(3) described in the Analysis.

Appendix Table 1. Schools in Sample vs. Public Schools in NCES

	NWEA Reading Schools			NWEA Math Schools			Public Schools Serving 6th-8th Grade		
	N	M	SD	N	M	SD	N	M	SD
6th grade	5,194	118.62	107.40	5,271	118.61	107.58	36,086	103.29	108.29
7th grade	4,887	130.58	118.60	4,948	130.14	118.25	31,085	119.88	129.18
8th grade	4,767	130.62	118.77	4,826	130.30	118.58	31,021	119.67	129.86
Minimum Grade Offered	5,779	3.41	2.97	5,863	3.39	2.97	41,433	3.22	3.08
Maximum Grade Offered	5,779	8.23	1.65	5,863	8.23	1.65	41,433	8.27	2.04
Percent FRPL	5,712	0.54	0.28	5,806	0.55	0.28	39,971	0.55	0.28
Percent Hispanic	5,779	0.19	0.24	5,863	0.19	0.24	41,434	0.22	0.27
Percent Black	5,779	0.18	0.28	5,863	0.18	0.28	41,434	0.15	0.24
Percent White	5,779	0.54	0.34	5,863	0.54	0.34	41,434	0.54	0.34
Percent Asian	5,779	0.03	0.07	5,863	0.03	0.07	41,434	0.03	0.08
City	5,779	0.31	0.46	5,863	0.31	0.46	41,414	0.27	0.44
Suburb	5,779	0.28	0.45	5,863	0.28	0.45	41,414	0.28	0.45
Town	5,779	0.12	0.32	5,863	0.12	0.32	41,414	0.12	0.32
Rural	5,779	0.29	0.45	5,863	0.29	0.45	41,414	0.33	0.47

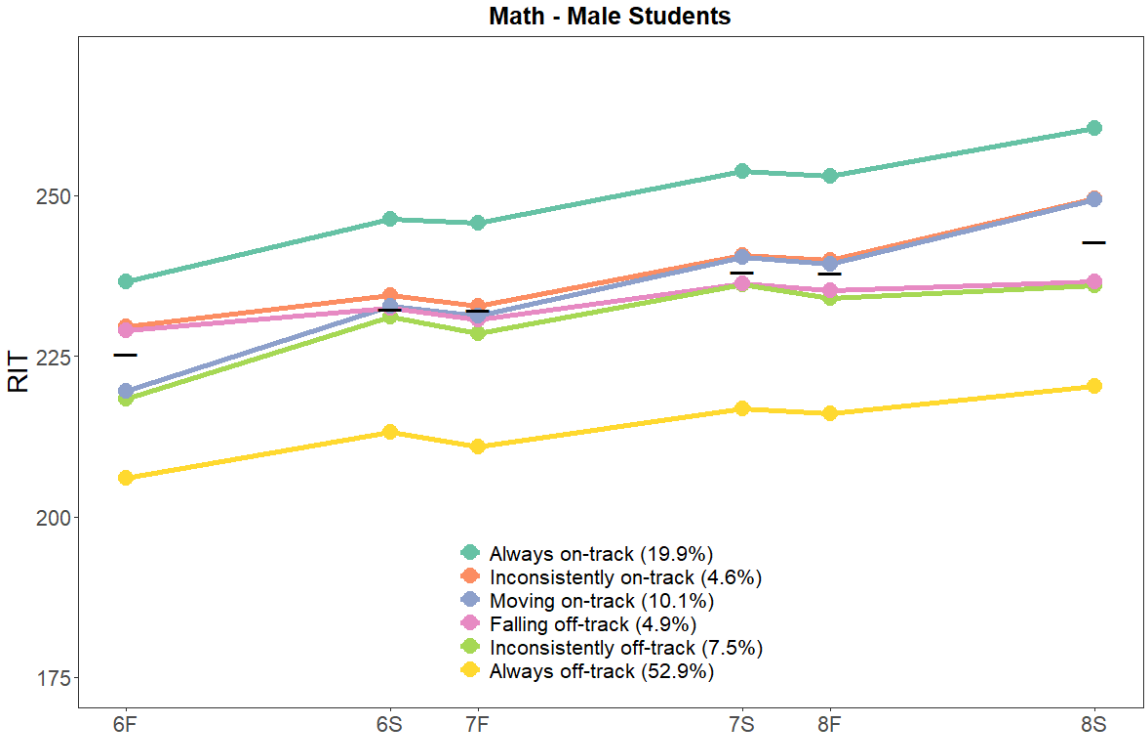
Appendix Table 2. Demographics of Analytic Sample vs. Full Data Set

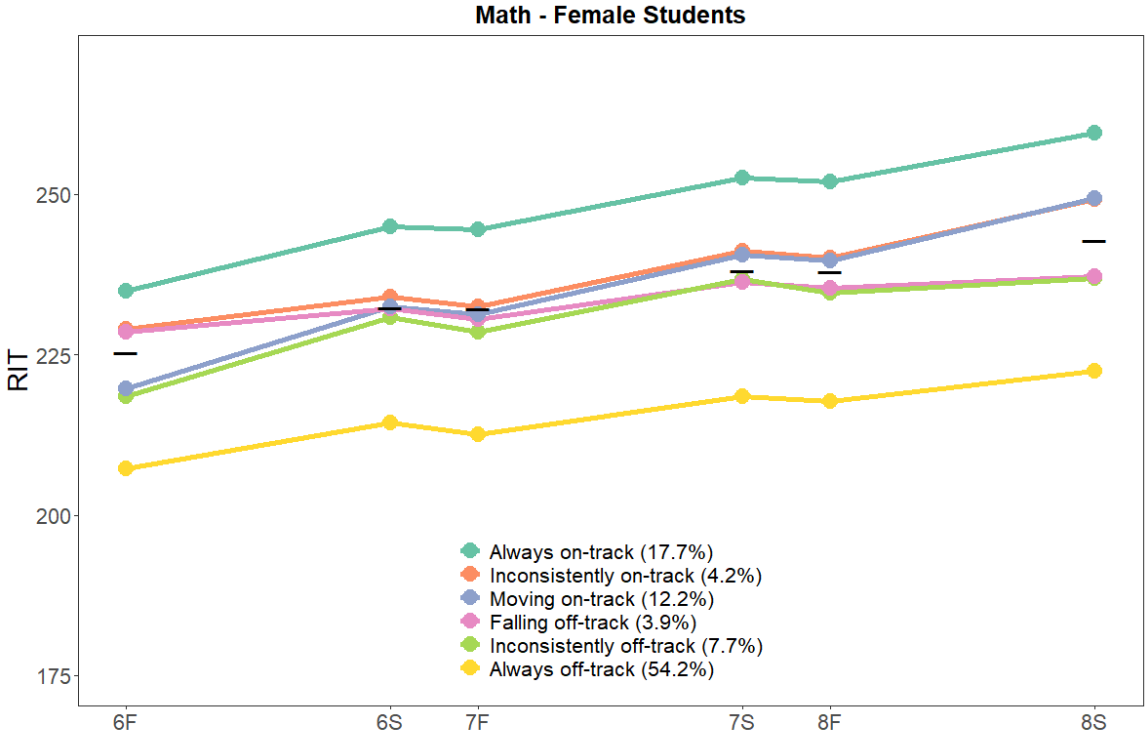
	Analytic Sample (Students Assessed in All 3 Grades)			Students Not Assessed in All 3 Grades			Full Data Set		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Male	0.51	0.50	363651	0.52	0.50	491459	0.51	0.50	855110
White	0.54	0.50	363958	0.47	0.50	492635	0.50	0.50	856593
Black	0.14	0.35	363958	0.18	0.38	492635	0.16	0.37	856593
Other Race	0.11	0.32	363958	0.14	0.35	492635	0.13	0.33	856593
Hispanic	0.17	0.37	363958	0.18	0.38	492635	0.17	0.38	856593
Asian	0.04	0.20	363958	0.04	0.20	492635	0.04	0.20	856593

Appendix Table 3. MAP Growth Benchmarks

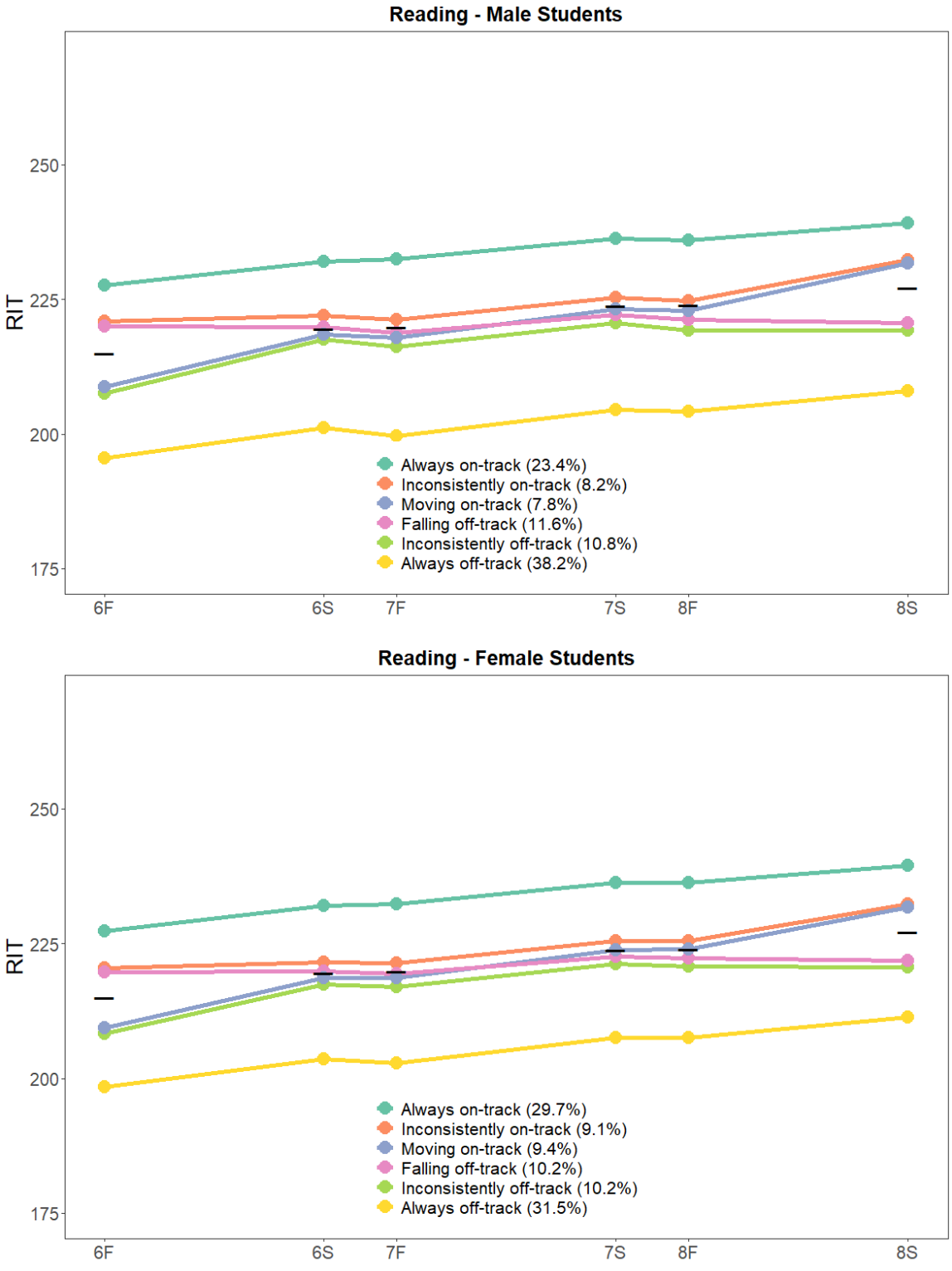
	Fall 6th Grade	Spring 6th Grade	Fall 7th Grade	Spring 7th Grade	Fall 8th Grade	Spring 8th Grade
Math						
Benchmark	225.30	232.34	232.20	238.06	238.00	242.73
Benchmark Percentile	68	66	71	70	74	74
Mean RIT (Sample)	216.43	225.01	223.22	230.30	229.26	234.81
Mean Percentile (Sample)	47	49	51	54	57	58
Percent Met Benchmark	28%	34%	30%	35%	32%	34%
Reading						
Benchmark	214.97	219.59	219.83	223.73	223.88	227.10
Benchmark Percentile	61	61	64	65	67	67
Mean RIT (Sample)	211.71	216.83	216.19	220.61	220.22	223.60
Mean Percentile (Sample)	52	53	55	56	58	59
Percent Met Benchmark	46%	47%	45%	46%	44%	44%

Appendix Figure 1. Growth Trajectories by Gender

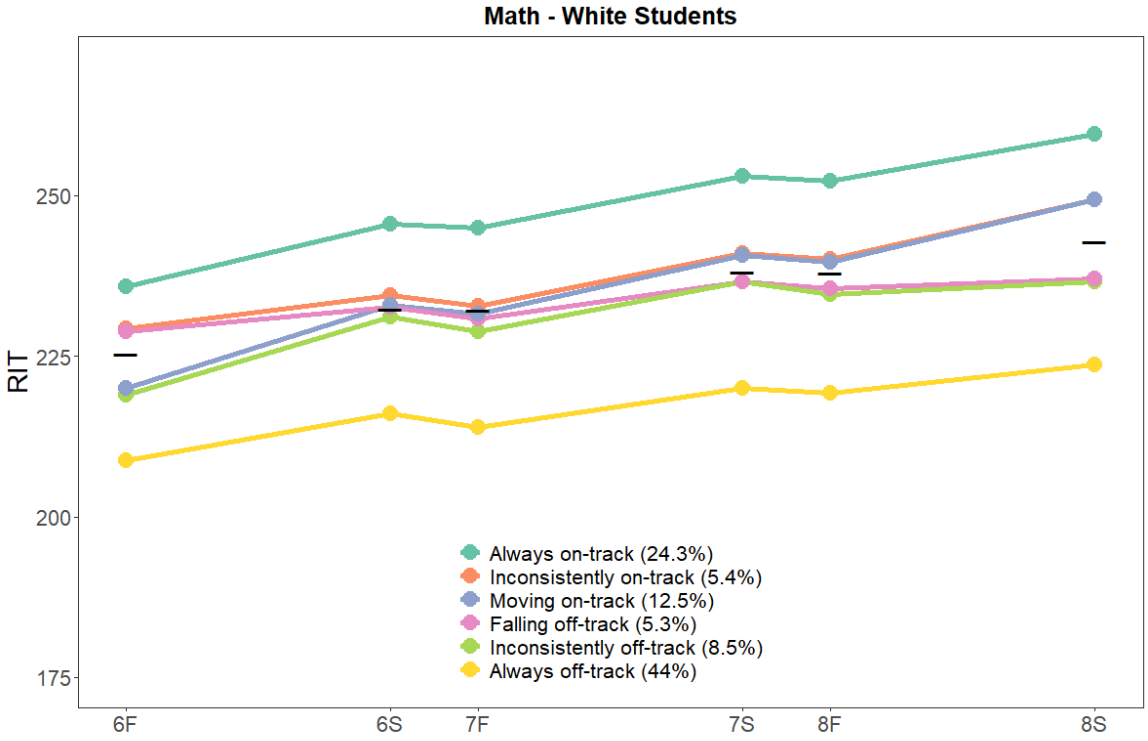


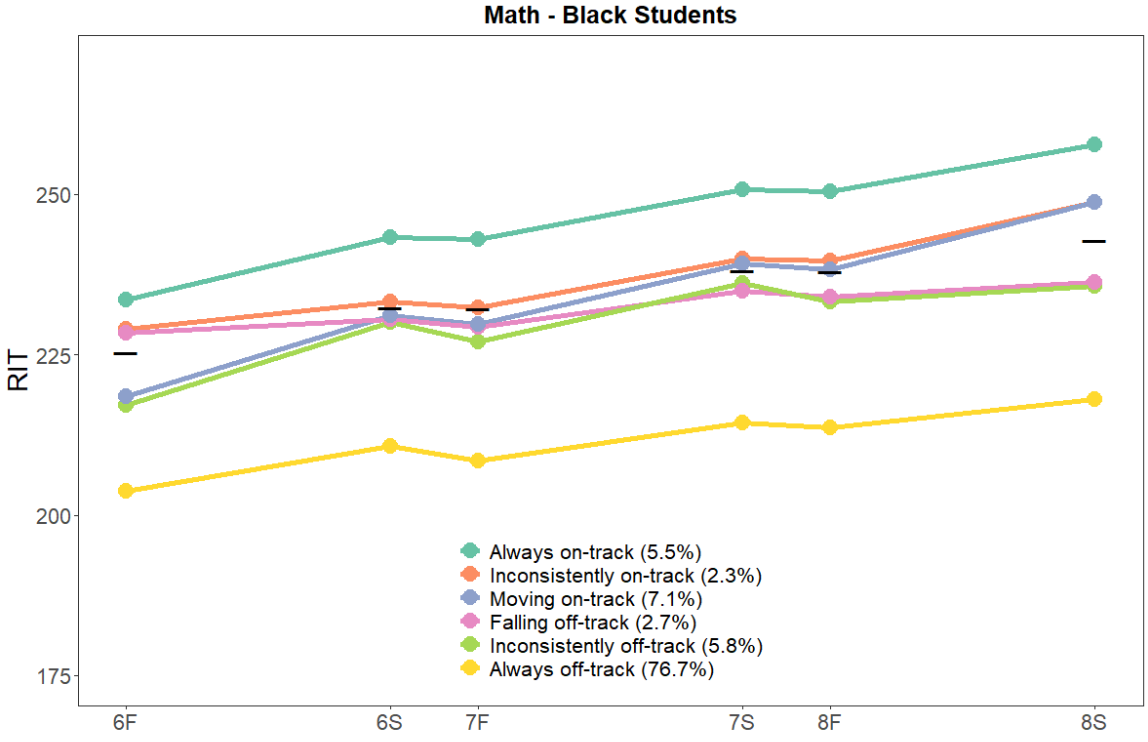


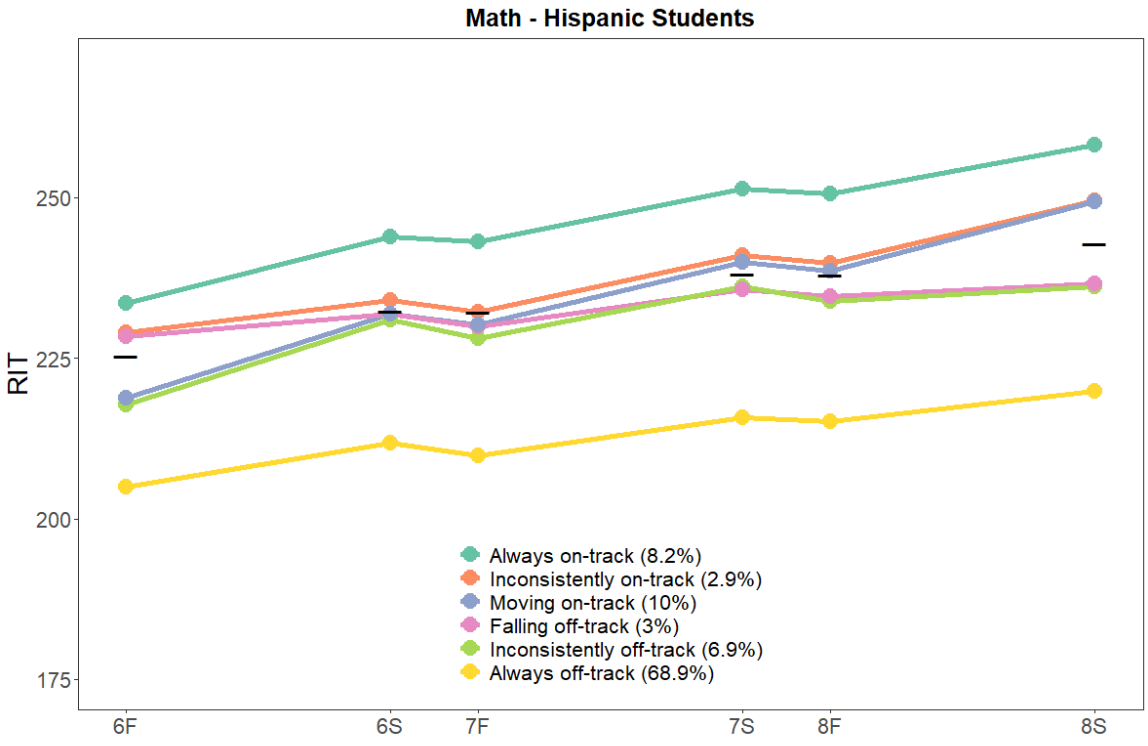
Appendix Figure 1. Growth Trajectories by Gender

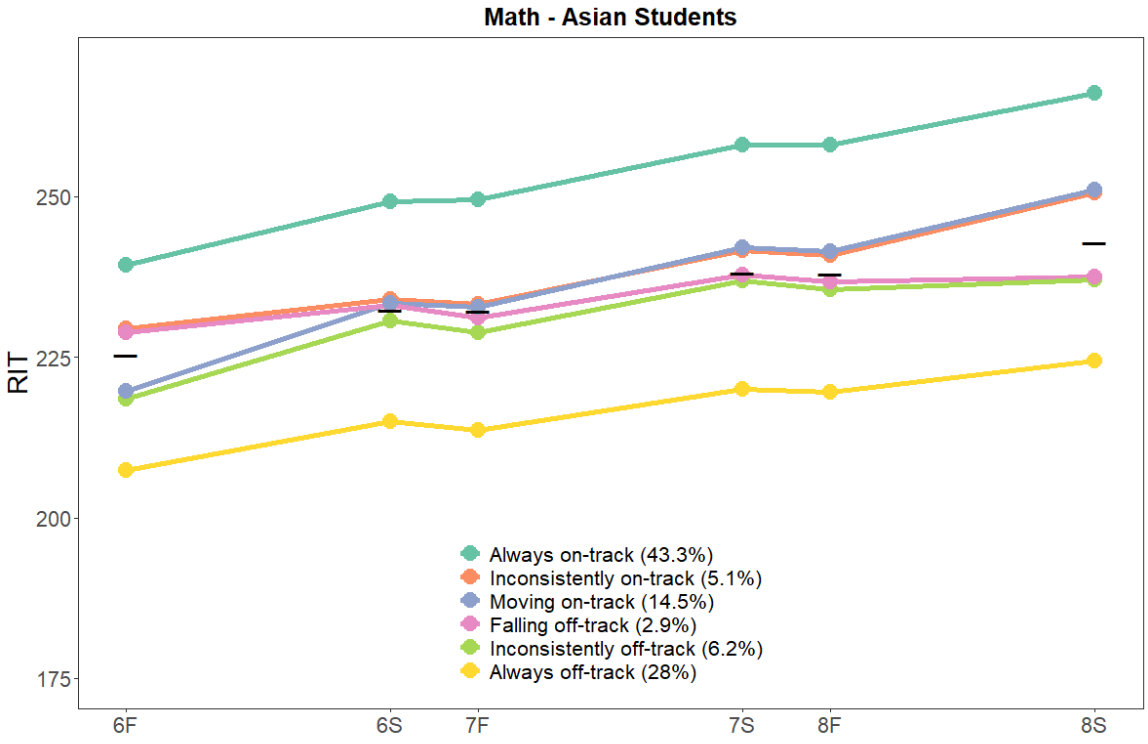


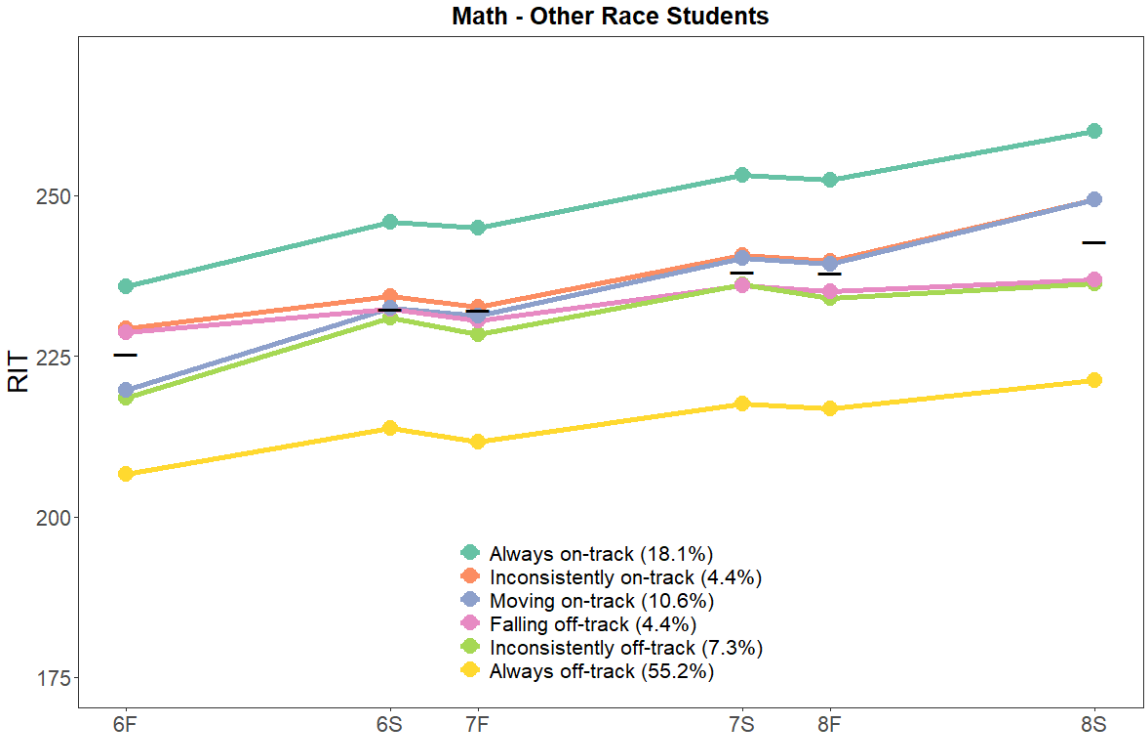
Appendix Figure 2. Math Growth Trajectories by Race/Ethnicity

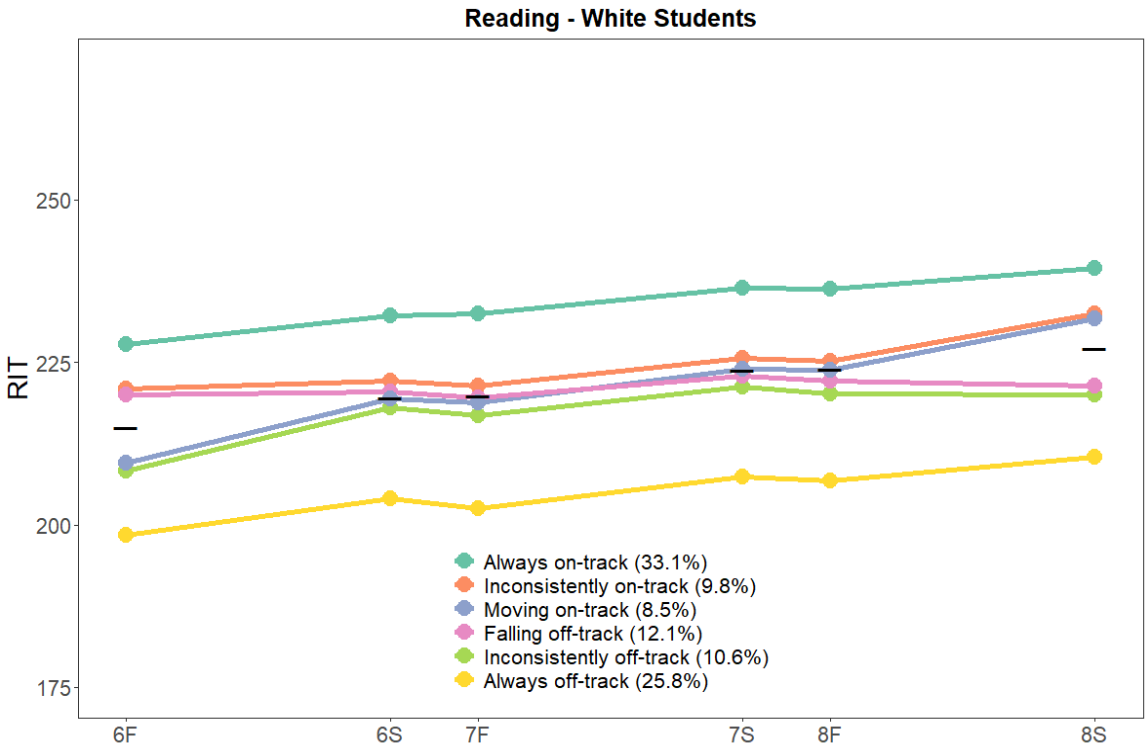


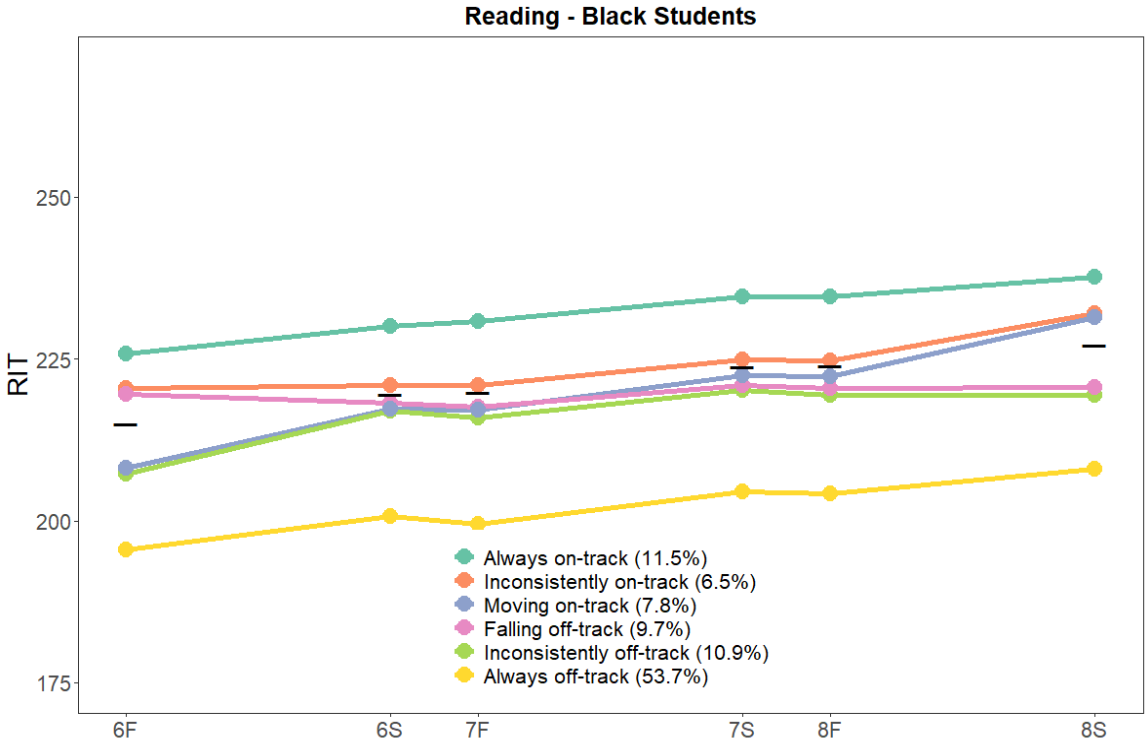


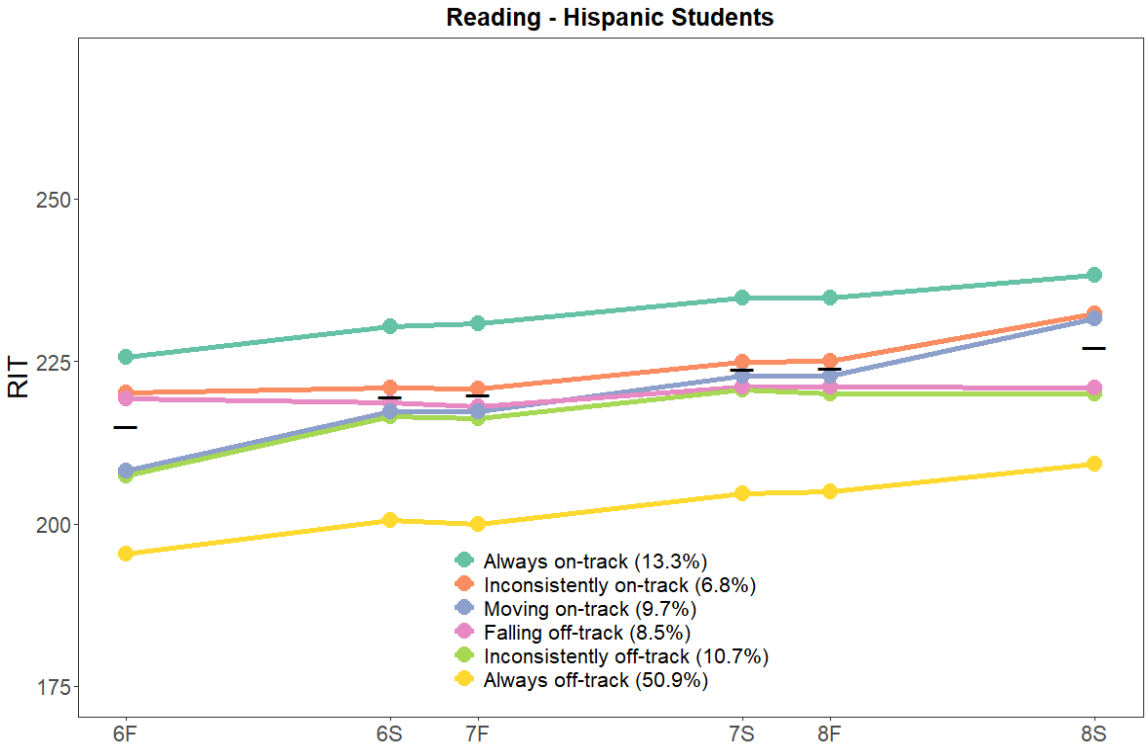

Math - Hispanic Students
RIT
250
225
200
175
6F
6S
7F
7S
8F
8S
Always on-track (8.2%)
Inconsistently on-track (2.9%)
Moving on-track (10%)
Falling off-track (3%)
Inconsistently off-track (6.9%)
Always off-track (68.9%)

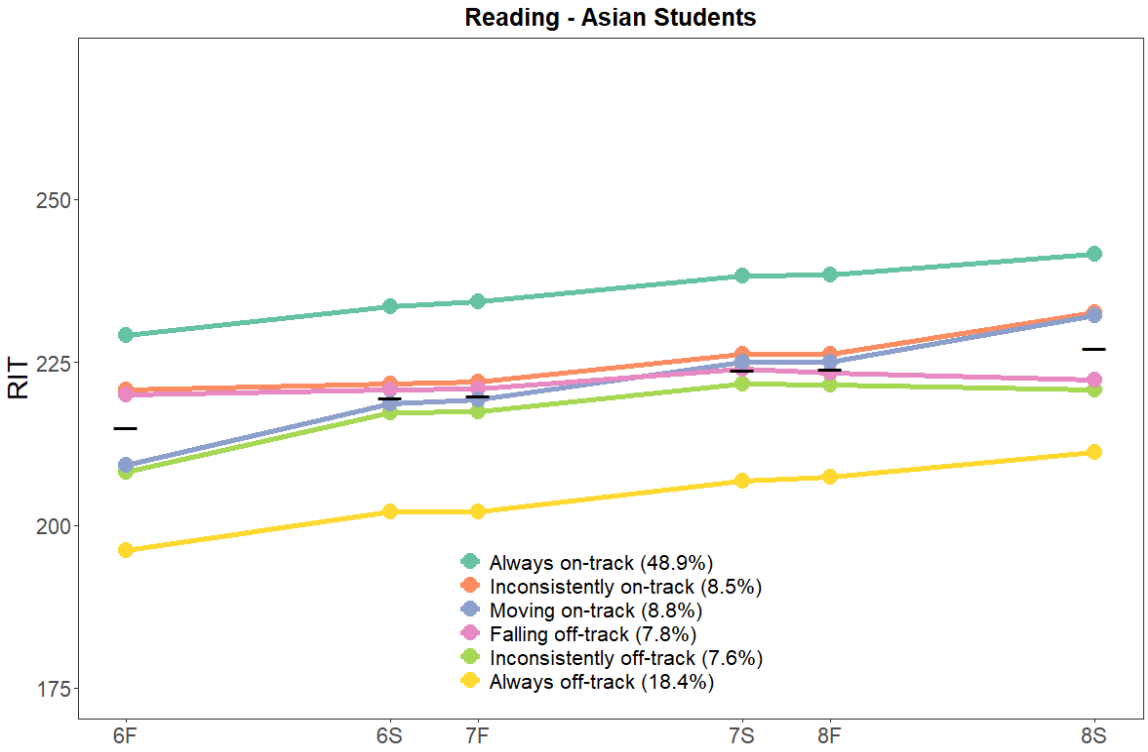

Math - Asian Students
RIT
250
225
200
175
6F
6S
7F
7S
8F
8S
Always on-track (43.3%)
Inconsistently on-track (5.1%)
Moving on-track (14.5%)
Falling off-track (2.9%)
Inconsistently off-track (6.2%)
Always off-track (28%)

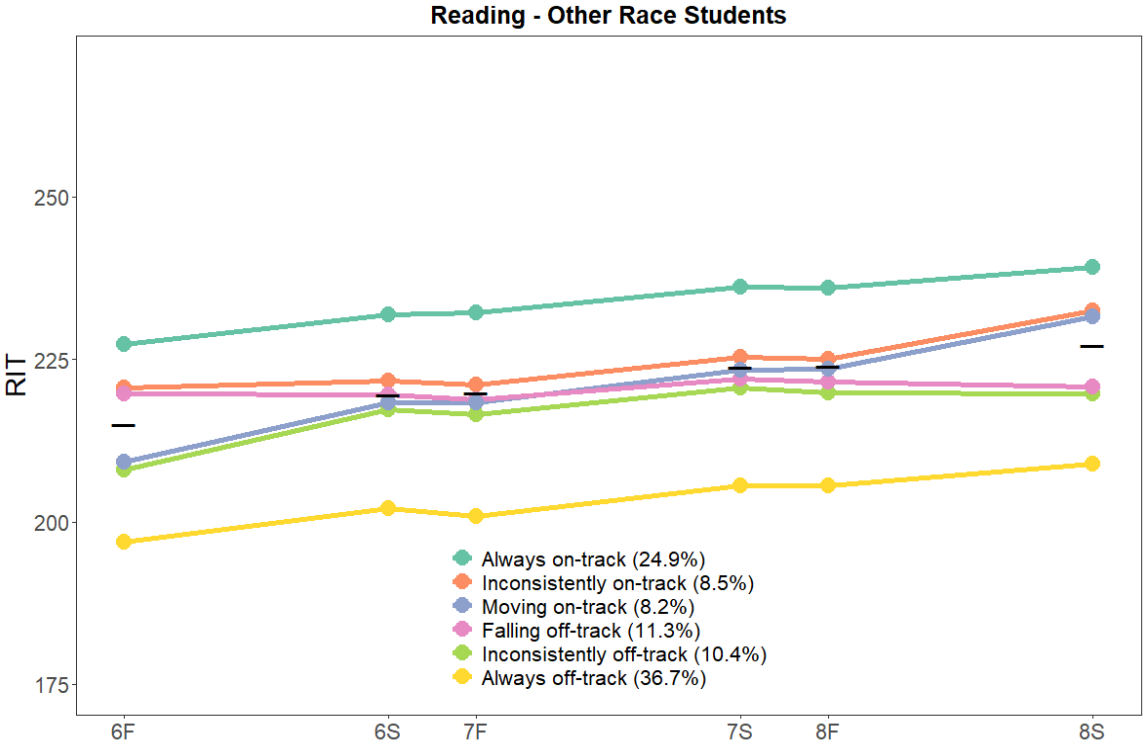

Math - Other Race Students
RIT
250
225
200
175
6F
6S
7F
7S
8F
8S
Always on-track (18.1%)
Inconsistently on-track (4.4%)
Moving on-track (10.6%)
Falling off-track (4.4%)
Inconsistently off-track (7.3%)
Always off-track (55.2%)


Reading - White Students
RIT
250
225
200
175
6F
6S
7F
7S
8F
8S
Always on-track (33.1%)
Inconsistently on-track (9.8%)
Moving on-track (8.5%)
Falling off-track (12.1%)
Inconsistently off-track (10.6%)
Always off-track (25.8%)


Reading - Black Students
RIT
250
225
200
175
6F
6S
7F
7S
8F
8S
Always on-track (11.5%)
Inconsistently on-track (6.5%)
Moving on-track (7.8%)
Falling off-track (9.7%)
Inconsistently off-track (10.9%)
Always off-track (53.7%)


Reading - Hispanic Students
RIT
250
225
200
175
6F
6S
7F
7S
8F
8S
Always on-track (13.3%)
Inconsistently on-track (6.8%)
Moving on-track (9.7%)
Falling off-track (8.5%)
Inconsistently off-track (10.7%)
Always off-track (50.9%)


Reading - Asian Students
RIT
250
225
200
175
6F
6S
7F
7S
8F
8S
Always on-track (48.9%)
Inconsistently on-track (8.5%)
Moving on-track (8.8%)
Falling off-track (7.8%)
Inconsistently off-track (7.6%)
Always off-track (18.4%)


Reading - Other Race Students
RIT
250
225
200
175
6F
6S
7F
7S
8F
8S
Always on-track (24.9%)
Inconsistently on-track (8.5%)
Moving on-track (8.2%)
Falling off-track (11.3%)
Inconsistently off-track (10.4%)
Always off-track (36.7%)